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of the American frigates in the war of 1812, says that some of them used shot weighted by a leaden core. This I believe is not true, but it shows the opinion of this old engineer, of the advantage that might be expected from increasing rather than diminishing the specific gravity of cannon-shot. Yet Captain Rodman's hollow shot seems to be looked to (pp. 289, 307) as the missile to meet iron-plated ships. Whether it is intended to explode them against the ship, or to depend upon their direct percussion, is not very clearly stated. The effect would probably be very much alike in both cases. Indeed, Captain Rodman admits (p. 298), that, although "none of these broke in the gun, some did break in the sand-bank after the sand had been packed hard by repeated firing." God forbid, then, that we should ever have to try them against the sides of the Gloire or the Warrior.

I have thus examined some of the prominent points in the labors of Captain Rodman, as they are detailed in his reports; and, without, as I hope, making any remark disrespectful to him as an officer and gentleman, I have declared freely what seems to me the value of the most important of the experiments and conclusions given in his work. Repeating here what I declared in an earlier part of this paper, that I think well of his method of cooling the hollow casting which is to form a gun, I think that there is good reason to believe that these guns will be somewhat superior to those made in the usual method. In the practice of casting in this way, however, great care must be observed to avoid the explosion which may occur should the cooling water find its way from its conductor into the body of the mould.

Five hundred and fourth meeting.

February 11, 1862. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters of acceptance from the Right Rev. Bishop Fitzpatrick and Dr. John Dean, recently elected Fellows, and from John M. Ordway, elected Associate Fellow of the Academy.

Professor Peirce, from the Committee to which the subject was referred, made a report upon the work of Capt. Humphreys and Lieut. Abbot, U. S. Topographical Engineers, upon the Mississippi River and the best mode of protecting its banks from overflow, — highly complimentary to the scientific character of their investigations. Professor Peirce proposed to offer a future and more detailed report, in conjunction with Mr. Runkle, who, upon his suggestion, was added to the Committee.

Professor Peirce made a second communication

Upon the System of Saturn.

The especial subject of this communication was, "The consideration of the subdivision of the ring into numerous small solid rings, and of the invalidity of the argument derived from statical conditions which has been urged against this subdivision." The investigation was conducted by the aid of completely integrated formulæ, which were obtained after much labor. The formulæ were embarrassed by terms which were subject to a reversal of sign when in a finite state, which can never happen in physical phenomena of this kind; but the embarrassment disappeared when it was observed that there were two different terms subject to the same paradoxical change of sign, and which were mutually antagonistic. From an exact numerical computation, it appears that, without violating the condition of statical equilibrium proposed in Mr. Bond's original memoir, Saturn's ring can be subdivided into about thirty-six rings of 600 miles of average breadth, with intervals of 150 miles between them. The inner and outer rings must be the broadest of all, and have a breadth of 800 or 1,000 miles, while the smallest of the intermediate rings will only have a breadth of 350 miles. It is curious that, with regard to the inner and outer rings, the attraction of each of these rings upon the surface which is towards the main body of the ring — that is, of the inner ring upon its outer edge, and of the outer ring upon its inner edge — is overbalanced by the attraction of the rest of the ring. Each of these portions of these rings, therefore, depends upon the combined action of Saturn and of its own centrifugal force to resist the destructive tendency of this external attraction. They have, therefore, each of them a time of revolution about Saturn, which properly belongs to no point of their mass, but to points of the general ring, intermediate between them.

The possibility of thus subdividing the ring into smaller ones without violating the statical condition proposed by Mr. Bond, proves that his argument was insufficient to demonstrate that the ring was not solid

In consequence of observations from Mr. Bond, Professor Peirce remarked that, as long as Saturn has a ring, the natural hypothesis of its solidity cannot be set aside from any argument of mere improbability, without the suggestion of some more probable hypothesis. The argument from uncomputed perturbation is especially vague and uncertain, and cannot be admitted into science, which is knowledge, and not ignorance. The hypothesis of a fluid ring was at the time of Mr. Bond's memoir more improbable than that of the subdivision into solids. For the mutual resistance of the particles of the ring to internal currents would sooner or later reduce the ring to one uniform velocity of revolution about Saturn, which would at once be its complete destruction, just as certainly as if it were solid. The fluid constitution is therefore quite impossible without some kind of action to counteract this tendency to break to pieces; and no such action was ever suggested or known to science until Mr. Peirce's own investigations upon the tidal action of the satellites.

Professor Peirce offered some remarks on Captain Rodman's work and experiments upon the construction of heavy ordnance. He regarded this work as of great scientific and practical value, and the observations as entitled to the highest confidence, on account of the accuracy and fidelity with which they are made. He found no corrections in the reductions of the observations which materially impair their value for the use for which they were made.

Five hundred and fifth meeting.

March 10, 1862. — ADJOURNED STATUTE MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters from Sir William Fairbairn and from Captain Duperrey, in acknowledgment of the official notification that they had been elected Foreign Honorary Members of the Academy. Also from Alvan Clark, Esq., of Cambridge, in acknowledgment of his election as a Fellow of the Academy.

Rev. James Mills Peirce, of Cambridge, was elected a Fellow, in Class I. Section 1.